

American Fern Journal

VOL. 44

APRIL-JUNE, 1954

No. 2

Ecological Observations on Pteridophyta in the Kangra Himalaya

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The Kangra Himalaya is a part of the main Himalayan range situated south-east of Kashmir. Two of the major valleys of this area (between Long. $77^{\circ} 5'$ – $77^{\circ} 40'$ E. and Lat. $31^{\circ} 55'$ – $32^{\circ} 30'$ N.) were visited by the author both before and after the onset of the monsoon during an expedition to these mountains in the summer of 1952. During these travels an intensive study of the distribution of pteridophytes in this area was made. Herbarium specimens of the species referred to in this paper are now housed in the British Museum (Natural History), London.

Observations were begun in the Beas River Valley (Kulu Valley) in dry pre-monsoon weather in mid-May. At the beginning of June the expedition travelled up the Parbati Valley and established a base camp at 12,800 feet altitude in the Dibibokri Nal, which leads off the Parbati Valley to the north. After the onset of the monsoon, the expedition returned in mid-July along the Parbati Valley. Subsequently further observations were made in the Beas Valley.

CLIMATE

In general, the rainfall in this western part of the Himalaya is considerably lower than that at comparable altitudes in the eastern part of the range such as Sikkim. At Kulu (4000 feet altitude), in one of the larger val-

[Volume 44, No. 1, of the JOURNAL, pp. 1–48, was issued April 8, 1954.]

leys of the Kangra Himalaya, the mean annual rainfall over a period of ten years (1942-1951) was 46.17 inches. Two periods of maximum rainfall occur each year, the first between January and March and the second from July to September. The period from April to June is fairly dry and from October to December very dry weather occurs. At Kulu, a complete drought in October or November is frequent. Unfortunately, no continuous records of rainfall in the higher valleys appear to be available. At the expedition's base camp (12,800 feet altitude) in July frequently no rain fell on days when it was reported to be raining heavily in the conifer forests lower down the Parbati Valley. According to local information, the conifer forests receive a greater rainfall than the valley floor of the Beas River.

The higher peaks in this range are covered with snow throughout the year and in the dwarf Juniper zone, at about 12,800 feet, snow is said to cover the ground from October until May. In the conifer forests, about 8000 feet, snow coverage of the ground is reported to last from January until March. The floors of the larger valleys, below 5000 feet, receive very little snow.

VEGETATION TYPES

In the wide valley of the Beas River in the environs of Kulu (Sultanpur), most of the more level land is arable and is under cultivation. Above this arable land, scrub of varying density ascends to the ridges where groups of pines often occur. The river flood-plains and also the banks of tributaries support alder woodland (*Alnus nitida*) or tall mesophytic scrub. Further up the valley, above 5000 feet, orchards have been planted on some of the arable land, and, yet further, extensive conifer plantations occur about the valley floor around Manali (6000 feet).

In contrast, the lowest reaches of the Parbati Valley

have little or no flood-plain and run in a gorge of steep mountain slopes colonized by open succulent *Euphorbia*-scrub or shorter and more dense mixed scrub in which species of *Berberis* are frequent constituents. At about 5000 feet, patches of pine forest (*Pinus Roxburghii*) interspersed with terraced fields become prominent in the landscape. Cedars (*Cedrus deodara*) become more frequent with increasing altitude and at about 7500 feet altitude a mixed forest of conifers, mainly pine (*Pinus Wallichiana*) and Cedar and deciduous trees (e.g. *Aesculus indica*) becomes common on the steep southern banks. In contrast, the northern banks at this point are more sparsely clad with trees and appear to be rather drier. Above 8000 feet, the terraced cultivated fields thin out and a belt of conifer forest extends up to the tree line of 11,000 feet. At higher altitudes in this zone, spruce (*Picea Smithiana*) becomes more prominent and, above 10,000 feet altitude, firs (*Abies spectabilis*) dominate the upper fringe of the conifer forests. Above 10,000 feet, the conifers are often mixed with a maple (*Acer* ? sp.) which occasionally forms pure stands.

Above the tree line, the vegetation is a mozaic of tall *Rhododendron campanulatum* scrub or low *Rhododendron cephalanthum* scrub on the steeper slopes, patches of silver birch (*Betula utilis*) woodland and grassy meadows. Above this belt, a dwarf juniper (*Juniperus pseudosabina* Hook.) begins to appear in quantity on grassed-over screes on east to south aspects. On longer-shaded colder slopes, *Rhododendron cephalanthum* forms extensive areas of short dense scrub. Both these small shrubs have an upper altitude limit in this area of about 13,000 feet, above which a landscape of scree and moraine boulders with short herbaceous vegetation between predominates up to the rock-faces and glaciers of the high peaks.

ARABLE AREAS

A variety of ferns occurs in the arable lands, usually on earthbanks among the terraced fields and on the stone walls among the habitations. *Ceterach Dalhousiae* (Hook.) C. Chr. is the most frequent fern, often growing together with *Onychium japonicum* (Thunb.) Kunze and *Pteris cretica* L. In drier positions, *Pellaea nitidula* (Wall.) Baker was seen growing about the bases of small scrub thickets. Dry but shaded stone walls provide a habitat for *Cheilanthes persica* (Bory) Mett., and more moist embankment walls often house large colonies of *Hypolepis punctata* (Thunb.) Mett. Moist ditches between fields and along watercourses in the townships offer a moist, though frequently exposed, habitat for a number of ferns including the following:

<i>Diplazium polymorphum</i> (Wall.) Presl	(o) ¹
<i>Cyclosorus dentatus</i> (Forsk.) Ching	(o)
<i>Hypolepis punctata</i> (Thunb.) Mett.	(f)
<i>Onychium japonicum</i> (Thunb.) Kunze	(c)
<i>Pteris cretica</i> L.	(o)
<i>Thelypteris brunnea</i> (Wall.) Ching	(o)

Only newly developed fronds were seen in May on the *Diplazium*, *Hypolepis*, and *Onychium*, and it appears that these species are deciduous in this habitat.

Above and among the arable fields, a short open scrub frequently occurs. On dry north-aspect hillsides in this scrub, both *Cheilanthes persica* (Bory) Mett. and *Ceterach officinarum* Lam. & DC. were found in crevices and on ledges of rock outcrops. At the time of collection in the dry, hot, pre-monsoon weather, the fronds of this *Ceterach* were inrolled, a feature occurring to a lesser degree in *Ceterach Dalhousiae* (Hook.) C. Chr.

Some of the arable land has been converted into apple, pear and cherry orchards. In some orchards at 6000

¹ The following abbreviations are used to indicate frequencies: a, abundant; c, common; l.c., locally common; f, frequent; l.f., locally frequent; o, occasional; r, rare.

feet, *Pteridium aquilinum* (L.) Kuhn var. *Wightianum* (Ag.) Tryon was prominent, and *Diplazium polymorphum* (Wall.) Presl and *Pteris cretica* L. were occasionally seen around boulder-bases about the margins of such orchards. In one waterlogged apple orchard, *Equisetum debile* Roxb. occurred in quantity during the monsoon rains.

RIVER FLOOD-PLAINS

Many areas of the wide flood-plain of the Beas River are occupied by alder woodland. In the gravelly soil of this habitat, large colonies of *Hypolepis punctata* have developed. In the flood-plains of the smaller rivers, a shorter and denser scrub is often present; the ground layer of this vegetation occasionally includes *Pteris vittata* L. and *Woodwardia unigemmata* (Mak.) Nakai in addition to the common *Hypolepis punctata*. After the onset of the monsoon, large quantities of a sterile *Marsilea* were found growing in almost stagnant backwaters.

VALLEY FLOOR CONIFER PLANTATIONS

The conifer plantations in the neighborhood of Manali have a ground layer vegetation in which pteridophytes are very prominent, the most frequent species being *Ceterach Dalhousiae*, *Diplazium polymorphum*, *Onychium contiguum* Hope, *Pteris cretica*, and *Selaginella chryso-caulis* (Hook. & Grev.) Spring. Along the banks of small streams in deep shade in one of the cedar forests, occasional colonies of *Pteris Wallichiana* Ag. were seen. The boulders and rock walls in these forests are largely inhabited by a different pteridophyte community community comprising the following species:

Adiantum venustum Don (l.f)

Asplenium Trichomanes L. (f)

A. varians Wall. ex Hook. & Grev. (o)

Leucostegia pulchra (Don) J. Smith (f)

Polypodium sp. aff. *P. microrhizoma* Clarke (f)

Polypodium sp. (sterile) (r)

It is interesting to note that fronds only appeared on the *Leucostegia* and *Polypodium* after the monsoon rains had begun.

On the margins of open glades among the conifer forests a number of ferns were seen growing about the bases of large boulders in varying degrees of shade afforded by the trees and isolated shrubs. These included *Athyrium puncticaule* (Blume) Moore, *Onychium contiguum*, *Polystichum nigropaleaceum* (Christ) Diels, *Pteris cretica* and *Thelypteris Levingei* (Clarke) Ching. In more shaded situations, *Asplenium Adiantum-nigrum* L., *Athyrium proliferum* Moore, and *Dryopteris odontoloma* (Moore) C. Chr. occurred in similar habitats.

In some of the steeper glades between cedar forests, artificially constructed water-courses leading to primitive water-mills were seen. Even in the dry season preceding the monsoon, the banks remained perpetually wet and were colonized by a wide variety of pteridophytes listed below.

Athyrium puncticaule (Blume) Moore (o)

Diplazium polymorphum (Wall.) Presl (c)

Equisetum arvense L. (o)

Osmunda Claytoniana L. var. *vestita* (Wall.) Milde (o)

Polystichum nepalense (Spreng.) C. Chr. (r)

P. Thomsonii (Hook. f.) Bedd., *forma* (o)

Thelypteris Levingei (Clarke) Ching (f)

DRY SCRUB

The slopes of the lower reaches of the Parbati Valley have been colonized by different types of scrub vegetation of various heights and densities. Extremely dry spurs where very little scrub has developed are extremely poor in pteridophytes. Occasionally colonies

of *Selaginella sanguinolenta* (L.) Spring f. *indica* (Milde) Alston and *Ceterach officinarum* were found on ledges and in crevices of huge cliffs along the route. A few colonies of *Adiantum incisum* Forsk. and *Hypolepis punctata* were also seen in this dry belt growing around the bases of boulders in some sheltered localities.

In the scrub proper many of the ferns appeared to be confined to the more shaded areas directly underneath small shrubs while others grew more luxuriantly in such situations. The following species were seen in this vegetation type:

Ceterach officinarum Lam. & DC. (c)

Dryopteris crenata (Forsk.) C. Chr. (o)

Dryopteris marginata (Wall.) Christ (o)

Lygodium sp. (r)

Pellaea nitidula (Wall.) Bak. (o)

Pteris cretica L. (o)

Pteris vittata L. (r)

Occasionally a few moist shaded walls and earthbanks in this zone were colonized by *Adiantum Capillus-ven-eris* L. A few individuals of *Diplazium polymorphum* and *Woodwardia unigemmata* were also found along the banks of some of the small streams that occur in this zone.

PINE-CEDAR ZONE

Between the patches of conifer forest, areas of scrub and terraced fields are quite common features of the mountain slopes. On the more exposed spurs, ferns such as *Asplenium Trichomanes*, *A. Adiantum-nigrum*, *Ceterach Dalhousiae*, *Onychium contiguum*, *Pteridium aquilinum* var. *Wightianum*, and *Pteris cretica* may be found growing about the bases of boulders. *Diplazium polymorphum* is quite prominent along the hedges of the fields and around boulder clumps. Denser scrub occurs in some of the more sheltered gullies in this zone and in such shaded habitats *Adiantum venustum*, *Asplenium*

varians, *Cheilanthes subvillosa* Hook., *Pteris aspericaulis* Wall. and *Thelypteris Levingei* make their appearance.

Some open, comparatively dry pine woodland is encountered in this zone and infrequently *Gymnopteris vestita* (Wall.) Underw. and *Pellaea nitidula* occur with the more common *Asplenium Trichomanes* on earthbanks in this vegetation. The closed pine and cedar forests in this zone offer a wide variety of habitats varying in humidity and density of shade. The following species were recorded in the field layer of these conifer forests:

- Adiantum Edgeworthii* Hook. (l.f.)
- A. venustum* Don (l.f.)
- Asplenium Adiantum-nigrum* L. (o)
- A. Trichomanes* L. (f)
- Athyrium* sp. aff. *A. flabellatum* (Clarke) Tardieu (f)
- Ceterach Dalhousiae* (Hook.) C. Chr. (c)
- Coniogramme affinis* (Wall.) Hieron. (r)
- Diplazium polymorphum* (Wall.) Presl (o)
- Dryopteris odontoloma* (Moore) C. Chr. (o)
- Onychium contiguum* Hope (c)
- Selaginella chrysocaulis* (Hook. & Grev.) Spring (l.f)
- Thelypteris Levingei* (Clarke) Ching (o)
- Woodwardia unigemmata* (Mak.) Nakai (l.f)

At higher altitudes, *Athyrium Schimperii* Moug. becomes common in some forest localities in this zone while *Coniogramme affinis* becomes increasingly frequent with increasing altitude. Moss covered boulders on the floors of these forests harbor a number of humicoles, such as *Adiantum venustum*, *Asplenium varians*, *Leucostegia pulchra*, *Polypodium nudum* (Hook.) Kunze, *Pyrrosia mollis* (Kunze) Ching, and at higher altitudes *Polypodium amoenum* Wall.

The mixed conifer-deciduous forests (ca. 8000 feet) have a field layer considerably richer in pteridophytes. Epiphytes are conspicuously absent; only one plant of

Polypodium nudum was seen growing epiphytically upon an old *Ilex* trunk. The following species were recorded on the floor of this type of forest and on the boulders within it:

FOREST FLOOR:

- Asplenium Adiantum-nigrum* L. (o)
A. Trichomanes L. (c)
Athyrium acrostichoides (Swartz) Diels (o)
A. Mackinnonii Hope (f)
A. puncticaule (Blume) Moore (o)
Coniogramme affinis (Wall.) Hieron. (c)
Diplazium polymorphum (Wall.) Presl (f)
Dryopteris odontoloma (Moore) C. Chr. (f)
Onychium contiguum Hope (f)
Polystichum nigropaleaceum (Christ) Diels (o)
Pteris cretica L. (o)
Thelypteris Levingei (Clarke) Ching (c)

BOULDERS:

- Adiantum venustum* Don (c)
Asplenium Adiantum-nigrum L. (o)
A. Trichomanes L. (c)
A. varians Wall. ex Hook. & Grev. (c)
Polypodium amoenum Wall. (o)
P. clathratum Clarke (l.f)

Open wet glades were not uncommon at the lower edges of this type of forest and large quantities of *Equisetum arvense* and some colonies of *Osmunda Claytoniana* var. *vestita* were seen in these habitats.

PINE-SPRUCE-FIR ZONE

This zone, which extends from an approximate altitude of 8500 feet to the tree-line at 11,000 feet, is composed largely of pine-spruce forests with an admixture of firs at the upper limits and also a number of deciduous trees. As in the lower conifer forests, ferns are also prominent in the undergrowth and include the following species:

- Adiantum venustum* Don (l.c.)
Asplenium Trichomanes L. (o)
Athyrium acrostichoides (Swartz) Diels (o)
A. Boryanum (Willd.) Tagawa (o)
A. Mackinnonii Hope (f)
A. flabellulatum (Clarke) Tardieu (l.f)
A. Schimperi Moug.² (f)
A. sp. aff. A. flabellulatum (Clarke) Tardieu (c)
Botrychium virginianum (L.) Swartz (r)
Coniogramme affinis (Wall.) Hieron. (f)
Dryopteris sp. (sterile) (o)
Onychium contiguum Hope (o)
Polystichum nigropaleaceum (Christ) Diels (o)
Thelypteris Levingei (Clarke) Ching (o)

At higher altitudes, above 10,000 feet, *Onychium contiguum* rapidly becomes scarce, while *Adiantum pedatum* L., *Cryptogramma Brunoniana* Wall., *Cystopteris fragilis* (L.) Bernh., *Diplazium squamigerum* (Mett.) Christ and *Dryopteris fibrillosa* (Clarke) Hand.-Mazz. become more frequent in the undergrowth. A number of humicoles were also found on boulders in these forests, and are listed below.

- Adiantum venustum* Don (f)
Asplenium Trichomanes L. (o)
A. varians Wall. ex Hook. & Grev. (l.f)
Coniogramme affinis (Wall.) Hieron. (f)
Cheilanthes Dalhousiae Hook. (o)
Polypodium amoenum Wall. (f)
P. loriforme Wall. (o)
P. malacodon Hook. (l.f)

Two epiphytes were found in this zone. Only one colony of *Polypodium clathratum* was seen on an old pine-trunk, but numerous plants of *Leucostegia pulchra*

² *Athyrium Schimperi* has a creeping rhizome; that of *A. flabellulatum* should be "dressé, à frondes en rosette," according to Mme. Tardieu. As most of the Schelpe specimens are without rhizomes, it is difficult to identify them with certainty.—A. H. G. Alston.

occurred as epiphytes on the deciduous trees. The fronds of the *Leucostegia* appear only after the onset of the monsoon rains. Clearings and forest margins in the lower part of this zone are populated by *Athyrium Mackinnonii*, *Diplazium polymorphum*, *Pteridium aquilinum* var. *Wightianum* and *Thelypteris Levingei*. In the more moist situations *Osmunda Claytoniana* var. *vestita* and *Equisetum arvense* are frequently seen. At higher altitudes many of these clearings are the result of landslides, especially near deeply eroding rivers. Among various other herbs which had colonized such areas *Athyrium Boryanum*, *A. acrostichoides*, *Dryopteris fibrillosa* and *Gymnocarpium remotum* (Hayata) Ching are found.

Moist to wet boulder-strewn gullies overgrown with *Viburnum*-scrub are encountered occasionally among the forests. In such habitats *Osmunda Claytoniana* var. *vestita* is locally common, associated with *Diplazium squamigerum*, *Polystichum moupinense* (Franch.) Bedd. and *Thelypteris Levingei*. *Osmunda* also forms large colonies along streams running across small alpine meadows among the forests about their upper limits. At altitudes along the tree-line, boulder clumps in the grasslands harbored a few ferns including *Asplenium Trichomanes*, *Athyrium Boryanum*, *Cystopteris fragilis*, and *Polystichum Prescottianum* (Wall.) Moore.

SILVER-BIRCH WOODLAND

A few ferns were seen on the boulder-strewn floor of this rather open woodland. The only species recorded were *Cryptogramma Brunoniana*, *Cystopteris fragilis*, *Polypodium bicolor*³ and *Polystichum Prescottianum*. A few colonies of *Equisetum arvense* were also found in some wet ground around the margin of this woodland.

³ *Polypodium bicolor* (Takeda) Alston, comb. nov.

Polypodium excavatum var. *bicolor* Takeda, Notes Bot. Gard. Edinburgh 8: 279. 1915.

RHODODENDRON-JUNIPERUS ZONE

The vegetation of this zone is composed of a mozaic of alpine meadows, scree grassland, and a number of shrub communities. On north to west aspects, areas of *Rhododendron campanulatum* scrub up to ten feet high occur usually on the more level ground while a short scrub (up to two feet high) of *Rhododendron cephalanthum*, occasionally admixed with *Rhododendron lepidotum*, occurs on steep rubble slopes among cliffs. On the warmer south to east aspects, *Juniperus pseudosabina* forms an open low scrub up to three feet high on rocky scree grassland. In some of the more dense patches of *Rhododendron campanulatum* scrub ferns are prominent in the undergrowth, including the following species:

Athyrium acrostichoides (Swartz) Diels (o)

A. Filix-femina (L.) Bernh. var. *dentigera* (Wall.) Bedd. (f)

Cystopteris fragilis (L.) Bernh. (o)

Dryopteris fibrillosa (Clarke) Hand.-Mazz. (f)

Polystichum Prescottianum (Wall.) Moore (f)

Cryptogramma Brunoniana was frequently seen on moss-covered boulders in this scrub.

Although *Equisetum arvense* was the only pteridophyte found in the higher parts of the *Rhododendron cephalanthum* short scrub, a number of ferns were seen about the lower limits of this vegetation in more sheltered situations. The species recorded were *Cryptogramma Brunoniana*, *Cystopteris fragilis*, *Dryopteris barbigera* (Moore) O. Ktze. and *Polypodium bicolor*. This *Polypodium* is particularly abundant in boulder scree in the lower parts of this zone where it is deciduous. A single plant of *Polypodium clathratum* was seen in a deep crevice of a cliff in this zone.

Landslides appear to be of frequent occurrence among the rhododendron scrubs. After some period while the rubble slopes become somewhat stable, they may be col-

onized by some of the smaller ferns, e.g. *Cryptogramma Brunoniana*, *Cystopteris fragilis* and *Woodsia* sp. aff. *W. Hancockii* Baker.

In comparison to the rhododendron scrub, the dwarf juniper scrub has a poor pteridophyte flora. Only *Botrychium Lunaria* (L.) Swartz and *Cryptogramma Brunoniana* were found in this community. *Cryptogramma Brunoniana*, *Cystopteris fragilis* and *Dryopteris barbigera* are occasionally found among the clumps of huge boulders which occur between patches of this scrub.

The open boulder-strewn grasslands and grassed screes among these different types of scrub are also inhabited by pteridophytes. Usually the ferns occur around the bases of boulders and are more frequent in wetter ground. The species found in such habitats are listed below.

Athyrium acrostichoides (Swartz) Diels (l.f)

Cryptogramma Brunoniana Wall. (o)

Cystopteris fragilis (L.) Bernh. (o)

Equisetum arvense L. (l.f)

Polystichum lachenense (Hook.) Bedd. (o)

P. moupinense (Franch.) Bedd. (o)

P. Prescottianum (Wall.) Moore (f)

Above the meadows and screes gaunt gneissic cliffs rise up steeply. In the crevices and on sheltered moist ledges in the rock faces of these cliffs, two interesting ferns were encountered. *Cryptogramma Stelleri* (Gmel.) Prantl was found to be locally frequent in a number of wet shaded crevices, where its brittle rhizome grew among damp moss mats. In deep but more exposed crevices, colonies of *Woodsia alpina* (Bolton) Gray were occasionally seen at about 13,000 feet. In the shallower crevices the mature fronds of this species are considerably smaller.

ALPINE ZONE

Above the upper limit of the juniper and rhododendron scrub, only three ferns were seen among the boulder-strewn grasslands on old moraines and scree. *Polystichum moupinense* was found around boulder bases up to an altitude of 14,000 feet and *Cystopteris fragilis* and *Polystichum Prescottianum* up to an altitude of 13,400 feet.

DISCUSSION

PAUCITY OF EPIPHYTIC SPECIES

The most striking feature of the pteridophyte flora in this western part of the Himalaya is the marked paucity of epiphytic species, both in variety and quantity. Kashyap (1925) noted that the paucity of epiphytic ferns increased westwards from the Kumaon and recorded that epiphytic orchids and ferns were absent in the drier inner valleys, e.g. the Sutlej. Mehra (1939) records that epiphytic ferns "thickly clad the tree trunks and branches" in Mussoorie with an annual rainfall of 86 inches (i.e. almost double that recorded at Kulu).

In the Kangra Himalaya, only one locally frequent epiphytic fern, *Leucostegia pulchra*, and single epiphytic colonies of *Polypodium clathratum* and *P. nudum* were found. It was observed that the epiphytic *Leucostegia* appeared to prefer the trunks of deciduous trees as substrata. This corresponds with the observations of Mehra (1939) in the Mussoorie district. In the higher valleys of the Kangra division, conifers far outnumber the deciduous trees, none of which have thick, persistent spongy bark. However, since only a few of the individual deciduous trees bear epiphytes, it seems probable that the comparatively low rainfall is largely responsible for the paucity of epiphytic ferns in the Kangra Himalaya, rather than a lack of suitable host trees.

THE DECIDUOUS HABIT

A number of authors have noted the fact that many ferns are deciduous, losing their foliage either in winter in temperate regions or in dry seasons in more tropical areas. The development of fronds after the onset of the rains from rhizomes dormant during the dry season has been recorded by Christ (1910), Mehra (1939), and others. In the Kangra Himalaya, it appears that both drought and low winter temperatures affect the periodic dormancy of some of the ferns of this region. However, a number of species are evergreen judging by the presence of old live fronds in the spring. In some of the deciduous species, young fronds were being developed before the onset of the monsoon, while in others no fronds were visible until the rains had begun at the end of June. It would appear that those deciduous ferns which produce fronds only after the onset of the rains are activated by increased humidity in addition to an increase in temperature in the spring. This temperature increase alone seems to be more important in starting the other group of deciduous ferns into growth. In considering the latter group though, it must be remembered that some rain does fall before the monsoon, but not with the intensity of the monsoon rains.

Evergreen species form a large part of the pteridophyte flora in the lower, comparatively drier and warmer valleys. All these species are terrestrial and include *Adiantum Zollingeri*, *Ceterach Dalhousiae*, *C. officinarum*, *Cheilanthes persica*, *Pellaea nitidula* and *Selaginella sanguinolenta*. The conifer forests also harbor a number of terrestrial evergreen species, which include *Adiantum venustum*, *Asplenium Adiantum-nigrum*, *A. Trichomanes* and *Polystichum nigropaleaceum*. Among the humicoles in this vegetation belt the leathery-leaved, evergreen *Polypodium loriforme* and *Pyrrosia mollis* also occur.

All the ferns in the Alpine and *Rhododendron* zones are apparently deciduous and were observed producing new fronds in June before the monsoon rains. *Equisetum arvense* in these two zones appeared in large quantities after the rains had begun, though only a single fertile stem was seen, this in short rhododendron scrub at 12,000 feet altitude in mid-June.

In the coniferous forests and in the scrub between them, the terrestrial species *Coniogramme affinis*, *Cryptogramma Brunoniana*, *Diplazium polymorphum*, *Onychium contiguum*, and *O. japonicum* were producing young fronds in the pre-monsoon period in early June. After the monsoon rains had begun another group of terrestrial forest ferns began to develop fronds, notably the species of *Athyrium* and also *Diplazium squamigerum* and *Thelypteris Levingei*. It is interesting to note that fronds were being produced before the monsoon on plants of *Athyrium puncticaule* and *Thelypteris Levingei* which were growing on the wet banks of water-courses at 6000 feet altitude. Among the forest humicoles growing on boulders, *Polypodium amoenum* began to produce fronds in the pre-monsoon period, but no new fronds were observed on plants of *Polypodium bicolor* or *P. clathratum* until after the onset of the monsoon. The most striking example of dormancy terminated by the monsoon rains was provided by the epiphytic *Leucostegia pulchra* which although seemingly absent in the pre-monsoon period, rapidly produced numerous fronds shortly after the rains began.

SUMMARY

The distribution of pteridophytes in the various vegetation types in the Kangra Himalaya is described. The deciduous habit in these ferns and the paucity of epiphytic species in this area are discussed.

ACKNOWLEDGMENTS

The author wishes to thank Mr. A. H. G. Alston, of the British Museum (Natural History), for identifying the greater part of the collection made by the author. The specimens collected are at the British Museum.

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The Hay-scented Fern, *Dennstaedtia punctilobula*

C. V. MORTON AND CHARLES NEIDORF

The hay-scented fern is one of the commonest and best known of the ferns of the northeastern United States. The illustration, a photograph by the junior author, was made from material collected near Yonkers, New York. It shows very well two of the important characteristics—the sorus and the hairs.

The sori are terminal on the anterior branches of the veins and are marginal in origin, although turned at maturity toward the lower side of the frond. The indusia are cup-shaped and originate as a low rim which grows until it assumes a spherical shape. The margins are later forced apart by the growing sporangia, but the indusia are never “dehiscent,” as they have been described. When young, the margins of the indusium are ciliate; however, the long, hyaline hairs are soon deciduous.